National Aeronautics and Space Administration
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MARSHALL STAR

Serving the Marshall Space Flight Center Community

March 30, 2006

Chandra finds evidence for quasar ignition

From the Smithsonian Astrophysical Observatory

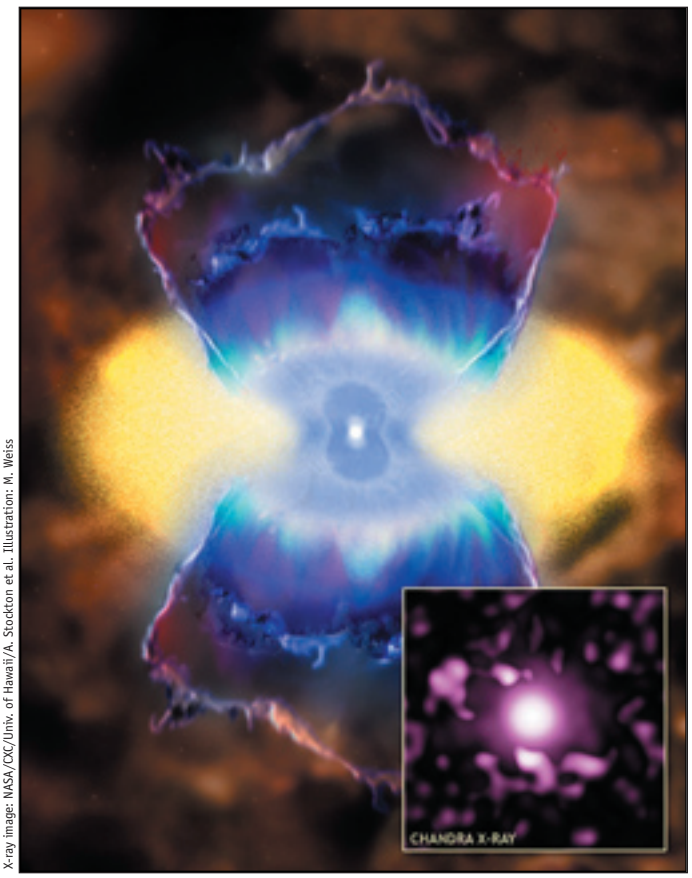
New data from NASA's Chandra X-ray Observatory, managed by the Marshall Center, may provide clues to how quasars "turn on." Since the discovery of quasars over 40 years ago, astronomers have been trying to understand the conditions surrounding the birth of these immensely powerful objects.

Hot, X-ray-producing regions around two distant quasars observed by Chandra are thought to have formed during their activation. These features are located tens of thousands of light years from the central supermassive black holes thought to power the quasars.

"The X-ray features are likely shock waves that could be a direct result of the turning on of the quasar about 4 billion years ago," said Alan Stockton of the University of Hawaii in Honolulu, and lead author of a report on this work published recently in The Astrophysical Journal.

The quasars, 4C37.43 and 3C249.1, showed no evidence of the existence of a much larger envelope of hot gas around the features, nor were the observed X-ray regions associated with radio waves from the quasars. These factors rule out possible explanations for the X-ray-emitting clouds, such as the cooling of hot intergalactic

See Chandra on page 5



X-ray image: NASA/CXC/Univ. of Hawaii/A. Stockton et al. Illustration: M. Weiss

An artist's illustration depicts a quasar in the center of a galaxy that is expelling gas at high speeds. The inset contains a Chandra X-ray image of the quasar 4C37.43.

New NASA 'tool set' will simplify engineers' efforts to better analyze space travel concepts and missions

By Sherrie Super

It's a complicated process — analyzing potential missions to other planets. Yet the highly technical task may go more smoothly in the future, thanks to a new set of NASA software tools.

The new "tool set," called Low-Thrust Trajectory Tools, will help engineers better analyze space-travel concepts and missions that use low-thrust propulsion technologies. Thrust is what propels a vehicle — enabling massive, towering rockets to lift heavy payloads free from Earth's gravity. Unlike conventional chemical rocket-driven systems, low-thrust technologies offer the promise of space travel using the sun's energy to propel spacecraft, greatly reducing the amount of fuel needed to travel in space. Such technologies include solar electric and solar sail propulsion.

The five tools are used to analyze simple Earth-centered and complicated multiple-body missions using any of a variety of propulsion systems. "The new tools were designed to improve mission analysis and better support technology-

See Tool set on page 4

Diagnosing medical conditions in space: NASA finds success in ultrasound imagery

By Lori Meggs

NASA has successfully proven ultrasound imagery can be used to diagnose medical conditions in space and remote locations on Earth when a physician is not readily available.

The Advanced Diagnostic Ultrasound in Microgravity experiment on the International Space Station investigated whether ultrasound — an imaging technique that uses high-frequency sound waves reflecting off internal body parts to create images for medical examination — can be used as a diagnostic tool in space.

Because no X-ray capability exists on the space station, ultrasound remains the only onboard imaging option for medical diagnosis of crewmembers. This experiment has shown that the crew, with minimal training and audio guidance from a certified expert on the ground, can produce ultrasound imagery of diagnostic quality.

Over the past three years, eight space station crewmembers on four expeditions — six-month missions on the station — participated in the experiment. These crewmembers acted as both experiment operators and subjects — completing comprehensive scans of the heart, chest and abdominal organs, and limited scans of the dental, sinus and eye structures. They also completed muscle and skeletal exams including a detailed assessment of the shoulder muscles.

NASA

Astronaut Leroy Chiao, right, conducts an eye exam on his Expedition 10 crewmate Salizhan Sharipov using ultrasound equipment on the International Space Station.

"Analysis of the ultrasound video downlinked to ground teams at the Johnson Space Center TeleScience Support Center in Houston has yielded excellent results," said Julie Robinson, deputy program scientist for the space station. "This study is establishing ultrasound as a key tool for clinical medicine on future vehicles to the moon and eventually Mars."

During Expedition 8 — the eighth research mission to the space station from October 2003 to April 2004 — crewmembers captured images of the heart, chest and blood vessel systems. These could help in diagnosing breathing difficulties, rib fractures and heart conditions.

Ultrasound images captured of the shoulder during Expedition 9 — from April to October 2004 — showed that ultrasound performed by crewmembers produced diagnostic-quality imagery for evaluation. For example, if a crewmember were to injure a shoulder during a strenuous spacewalk, these techniques would allow evaluation and diagnosis of possible injuries.

"We were able to collaborate with the ground to obtain the best possible imagery," said Mike Fincke, Expedition 9 astronaut. "It was clear that we could use the ultrasound to help in a wide variety of medical situations." Fincke was lead author on a scientific paper discussing his work on the space station.

Following a traumatic event to the head or face, an eye examination is a very important component of the physical examination. From October 2004 to April 2005, the Expedition 10 crew used ultrasound technology to examine the eye through the closed eyelid. This could determine a number of problems with the eye, including many that are signs of more significant trauma to the head.

The final ultrasound experiment on the station was jointly conducted by Expedition 10 and 11 crewmembers in April 2005. They performed heart and chest scans. This session, which would normally be video downlinked, was performed by using voice only — a new capability. Crewmembers described to the ground team exactly what image they were obtaining, and the ground team then

See Ultrasound on page 7

Marshall challenge helps employees lose weight, get fit

By Sherrie Super

Astronauts aren't the only NASA employees who focus on fitness. More than 150 Marshall Center team members have lost 874 pounds, inspired by the Weigh-to-Win Competition — an annual event sponsored by the NASA Exchange Wellness Center.

The competition gave teams of up to five people the opportunity to lose weight, build muscle and compete for prizes. This is the third year for the competition, the brainchild of Tremad Dunham, an exercise specialist at the Wellness Center.

"At the beginning of the year, nearly everyone wants to lose weight," Dunham said. "We set this up to be a team effort, with team captains and fellow members encouraging each other."

With a bevy of creative names ranging from the Lard Buckets to Wasting Away, 35 teams lined up to compete. The event began in mid-January.

A $5 entry fee covered the cost of prizes, and participants spent the next eight weeks earning points by working out, losing weight and building muscle.

"One person lost 40 pounds," Dunham said. "We had several other people lose 18, 20 or 25 pounds. Weight loss in the twenties was getting to be almost normal."

"The Weigh-to-Win challenge is a great way to establish good habits," said Brooke Boen, captain of the winning team, So Buff — a name selected to reflect the team's fitness goals. "Even if your final goals take longer than eight weeks, this is a perfect kick-start."

Emmett Given/MSFC

At the NASA Exchange Wellness Center, exercise specialist Tremad Dunham, far left, guides Weigh-to-Win contestants Brooke Boen, center, and Lori Meggs.

Boen said her team's winning philosophy was simple but not always easy. "Our team approach was fairly basic: Eat a little less, move a lot more. Despite Super Bowl and Mardi Gras temptations, they were dedicated right to the end of the challenge," she said.

Dunham said the response this year was more than anticipated, with nearly double the number of teams compared to prior years. The increased participation, he said, may have stemmed from a new emphasis on trimming body fat.

"We had many more people this year who didn't have a lot of weight to lose," he said. "But they wanted to firm up and lose body fat. We had some people losing 5-to-7 percent body fat."

Dunham believes that everyone who completed the challenge is a winner. "Even for those who didn't make it into the top three teams or didn't achieve their goals, I'm hoping they can keep it up year-round," he said.

The writer, an ASRI employee, supports the Public and Employee Communications Office.

Marshall Weigh-to-Win finalists lose big

First place: So Buff
Brooke Boen
Alyssa Bermea
Ed Bermea
Lori Johnston Meggs
Sherrie Super

Second place: The Winning Losers
Allison Lee
Ron Cantrell
Michael Cole
John Oddo
Christy Gattis

Third place: Git "R" Done
Nathan Coffee
Cindy King
Sheila Koza
Robbie Saint
Valerie Singleton

Tool set

Continued from page 1

development decisions across NASA," said Melody Herrmann of the Marshall Center. Herrmann is the manager of the Technology Planning and Systems Analysis area within NASA's In-Space Propulsion Technology Project.

The development of the tool set was funded by the In-Space Propulsion Technology Program, a NASA program managed by the Science Mission Directorate at NASA Headquarters. The program is implemented at Marshall by the In-Space Propulsion Technology Project, an organization charged with developing new propulsion technologies for robotic science missions.

The collaborative effort began in 2002 when In-Space Propulsion Technology Program managers at NASA Headquarters identified the need to standardize and improve tools used for mission analysis. The effort, led by Marshall's Larry Kos of the Advanced Concepts Office, brought together four NASA centers — the Glenn Research Center, Cleveland; the Jet Propulsion Laboratory, Pasadena, Calif.; the Johnson Space Center, Houston; and the Marshall Center — to develop the new tools.

"Some of the original tools were difficult to use, lacked user guides or only operated on certain computer systems," said Kos. "Use of different tools generated inconsistent results for similar missions. In contrast, the new tool set ensures more consistent and accurate analysis with documentation to help educate and train the analysts."

"These world-class tools will provide excellent analysis for in-space transportation planning and pave the way for NASA's mission analysis community to infuse low-thrust technologies into future mission plans."

— Rae Ann Meyer, manager of the In-Space Propulsion Technology Project at the Marshall Center

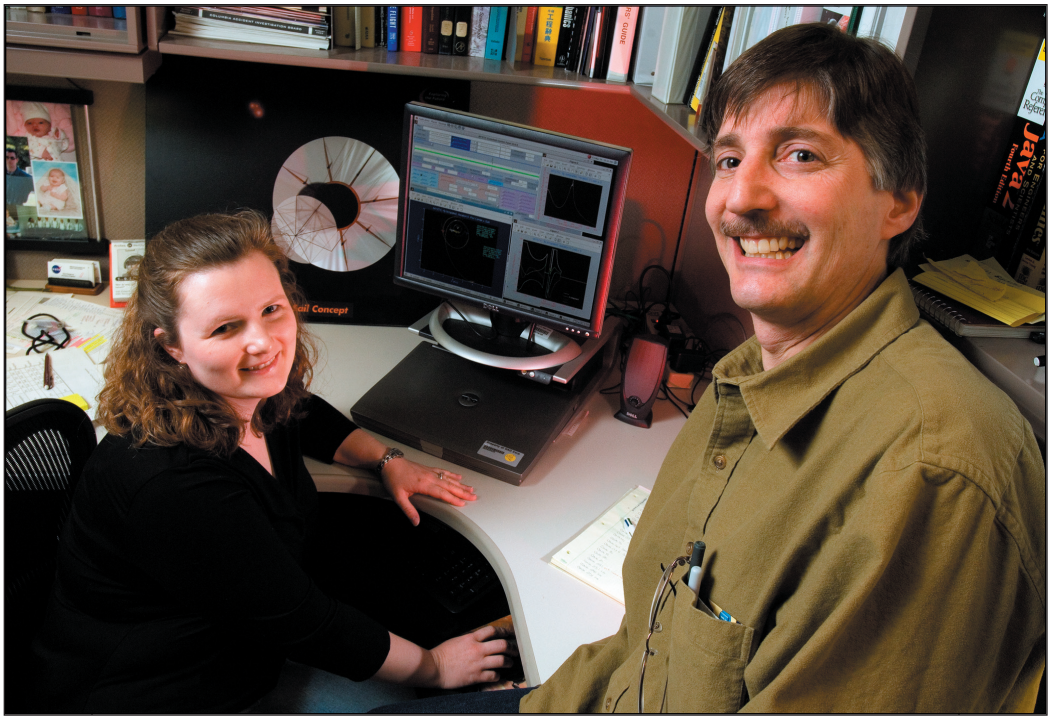
The new tools embody the latest advances in low-thrust trajectory design and optimization. Early versions of these tools have been used by scientists and engineers in concept studies including NASA's Robotic Lunar Exploration Program, a series of robotic missions to support human exploration of the moon, and Dawn, a solar electric propulsion Discovery mission.

The tools already have proven their merit in the international arena. The Jet Propulsion Laboratory used one of the tools from the LTTT tool set, MALTO — short for Mission Analysis Low-Thrust Optimization — to win the European Space Agency's International Mission Design Competition in January. The win recognized their design for an asteroid intercept mission that included multiple flybys of Earth, Venus, Saturn and Jupiter. The design was judged the best of 12 submissions from space agencies all over the world.

"These world-class tools will provide excellent analysis for in-space transportation planning and pave the way for NASA's mission analysis community to infuse low-thrust technologies into future mission plans," said Rae Ann Meyer, manager of the In-Space Propulsion Technology Project at the Marshall Center.

The roll-out of LTTT Version 1 and demonstration of the set of tools was the focus of the Low-Thrust Technology Technical Interchange Meeting hosted by the Marshall Center March 28-29. The tools and guides will be accessible on the Web at http://www.inspacepropulsion.com/LTTT .

The writer, an ASRI employee, supports the Public and Employee Communications Office.



David Higginbotham/MSFC

Tara Polsgrove and Larry Kos of the Marshall Center use Low-Thrust Trajectory Tools, new software for analyzing missions that use low-thrust propulsion technologies.

Chandra quick fact

Unlike the Hubble Space Telescope's circular orbit that is relatively close to the Earth, the Chandra X-ray Observatory was placed in a highly elliptical — or oval-shaped — orbit. At its closest approach to Earth, the observatory reaches an altitude of about 6,000 miles. At its farthest point of approximately 86,400 miles, Chandra travels almost one-third of the way to the moon.

It takes Chandra 64 hours to complete one full orbit, during which the observatory takes uninterrupted observations for about 55 hours. Chandra cannot take science observations while it travels through the radiation belts that surround the Earth because the radiation can disturb Chandra's sensitive instruments.

Chandra

Continued from page 1

gas, or heating by high-energy jets from the quasars.

"The best explanation for our observations is that a burst of star formation, or the activation of the quasar itself, is driving an enormous amount of gas away from the quasar's host galaxy at extremely high speeds," said Hai Fu, a co-author of the study who is also from the University of Hawaii.

Computer simulations of the formation of stars and the growth of black holes during a collision between two galaxies are consistent with this picture. The simulations, performed by Tiziana Di Matteo of Carnegie-Mellon University in Pittsburgh, Penn., and colleagues, show that the merger of galaxies drives gas toward the central regions where it triggers a burst of star formation and provides fuel for the growth of a central black hole.

The inflow of gas into the black hole releases a tremendous amount of energy, and a quasar is born. The power output of the quasar dwarfs that of the surrounding galaxy and expels gas from the galaxy in what has been termed a galactic superwind. The Chandra data provide the best evidence yet for a quasar-produced superwind.

Over a period of about 100 million years, the superwind will drive all the gas away from the central regions of the galaxy, quenching both star formation and further black hole growth. The quasar phase will end and the galaxy will settle down to a relatively quiet life. The tranquility of the galaxy will be interrupted from time to time as a small satellite galaxy is captured and provides food for the otherwise dormant supermassive black hole.

Marshall manages the Chandra program for NASA's Science Mission Directorate. The Smithsonian Astrophysical Observatory provides science support and controls flight operations from the Chandra X-ray Center in Cambridge, Mass.

Industry invited to help plan NASA strategy for Crew Launch Vehicle element

NASA's Exploration Systems Mission Directorate in Washington has invited the aerospace industry to help plan procurement strategies and development of a new upper-stage propulsion element that will help lift explorers to the moon in the coming decade.

The upper stage, an element that takes over propulsive duties from a spent first-stage rocket to complete a launch to orbit, is in development by the Marshall Center's Constellation Systems Launch Vehicles Project Office.

It is a critical component of the Crew Launch Vehicle, the successor to the space shuttle and the anticipated flagship in NASA's next-generation space fleet.

NASA's Request for Information, issued last week, asks respondents to suggest potential technical and business solutions facing the new upper stage development effort, and invites opinions regarding specific procurement and job-execution strategies.

NASA will not issue any contracts based on responses to the request, which is intended solely to help the agency define its upper-stage development plans. The document is available on the Web at http://prod.nais.nasa.gov/cgi-bin/eps/synopsis.cgi?acqid=119491 .

On April 18-19, NASA will update industry on its development design and strategy during an open-house event at NASA's Michoud Assembly Facility in New Orleans. Michoud is one of the facilities selected to manufacture and assemble the new upper stage.

The Crew Launch Vehicle effort, led for NASA by the Marshall Center, is at the core of the agency's plan to develop a cost-effective space transportation system that can safely and reliably carry human explorers to the moon, Mars and beyond.

For more information, visit http://www.nasa.gov/exploration .

NASA/John Frassanito and Associates

Artist's concept of Crew Exploration Vehicle and lunar lander returning to the moon.

Marshall manager to visit students to discuss NASA's future

By Bill Hubscher

Thanks to the NASA Explorer Schools program, the next student assembly at Jones Cove Elementary School in Cosby, Tenn., should be out of this world.

Last spring, the school was accepted into the NASA Explorer Schools Program, a national effort to increase student interest and participation in science, technology, engineering and mathematics. Jones Cove Elementary students, teachers and a pair of special guests from the agency will celebrate the beginning of the partnership in a ceremony April 4.

Veteran astronaut Dr. Roger Crouch, who has logged more than 471 hours in space on two space shuttle missions, and Jim Ellis, manager of the Academic Affairs Office at the Marshall Center, will visit Jones Cove Elementary on April 3-4 to kick off the school's participation in the program and share NASA's Vision for Space Exploration.

Crouch and Ellis will discuss how space and science research enhance life on Earth. "We believe it is important to inspire and encourage students in these fields, because this generation will be tomorrow's engineers, scientists and space explorers and will help us return to the moon, and reach out for Mars and destinations beyond," Ellis said.

Created in 2003, the NASA Explorer Schools Program is a three-year partnership between the agency and selected schools to provide opportunities and materials for teachers to spark student interest in subjects that can possibly lead to a future in space exploration. NASA's Office of Education in Washington sponsors the program and chooses up to 50 new schools to enter the program each spring.

To date, there are 186 Explorer Schools throughout all 50 states and the District of Columbia with more than 125,000 students involved in the program.

For information about the NASA Explorer Schools Program on the Internet, visit: http://explorerschools.nasa.gov .

The writer, an ASRI employee, supports the Public and Employee Communications Office.

NASA/JSC

Astronaut Bill McArthur participates in the Foot experiment in the Destiny laboratory.

Expedition 12 commander McArthur participates in final Foot experiment

By Lori Meggs

Expedition 12 commander and NASA Science Officer Bill McArthur recently put on his customized Lycra cycling tights for the final session of the Foot/Ground Reaction Forces During Spaceflight, or Foot experiment.

Foot investigates the differences between use of the body's lower extremities on Earth and in space, as well as changes in the musculoskeletal system during space flight.

For this session, McArthur wore the instrumented Lower Extremity Monitoring Suit, or LEMS, which measured his joint angles, muscle activity and forces on the feet during his exercise routines on the cycle ergometer and the resistive exercise devices.

It marked the completion of this highly successful space station experiment, which began on Expedition 6. It has provided valuable insight into the exact loads crewmembers experience on their lower extremities in space flight, which will aid in the understanding of bone loss during long-duration missions and the use of exercise as a countermeasure to prevent it.

Educational Payload Operations activities also were conducted by the science officer. McArthur videotaped a demonstration of sleeping on the station in microgravity. He also showed part of his typical morning routine. The session will be used in NASA educational products.

NASA's payload operations team at the Marshall Center coordinates U.S. science activities on the space station.

The writer, an ASRI employee, supports the Public and Employee Communications Office.

Ultrasound

Continued from page 2

guided the crew with specific directions. The voice capability would be helpful in the event the crew was unable to send the video imagery. Ultrasound technology is now used in many trauma centers around the world as a first-line diagnostic procedure when assessing abdominal trauma. The use of the technology as a diagnostic tool on the space station required pre-flight training by the crew, an on-board skill enhancement program and direction from ground-based personnel. A "cue card" to illustrate anatomical markers for target areas to be scanned was created for the crew to reference during the ultrasound session.

The success of the ultrasound experiment may also lead to additional applications of the procedure on Earth. The techniques can be adapted on Earth for patients in remote areas, during disaster relief efforts and for military use.

"We have been applying the same methods developed for NASA to provide remotely guided ultrasound for sports teams and Olympic athletes," said Dr. Scott Dulchavsky, principal investigator for the experiment. "Remote guidance can also be used to extend ultrasound beyond where it is currently available, such as rural areas or ambulances in transit." Dulchavsky is chairman of the Department of Surgery at the Henry Ford Health System in Detroit.

NASA's payload operations team at the Marshall Center coordinates all U.S. science activities on board the space station. Marshall is more than a rocket center: It is involved in some of the most exciting scientific discoveries of the decade. It makes Marshall unique as a NASA center that leads not only in getting people into space, but also in asking and answering the important scientific questions once we are there.

The writer, an ASRI employee, supports the Public and Employee Communications Office.

Classified Ads

To submit a classified ad to the Marshall Star, go to Inside Marshall, to "Employee Resources," and click on "Employee Ads — Submit Ad." Ads are limited to 15 words, including contact numbers. No sales pitches. Deadline for the next issue is 4:30 p.m. Thursday.

Miscellaneous

"The Beatles Yesterday and Today," peeled Butcher album, $300. 430-1054 after 5 p.m.

Antique drafting table w/mechanical arm, $125. 931-438-2625

La-Z-Boy lift power recliner, $300; beige wing back chair, $40; jump start system, $18. 852-6952

Golden retriever pups, AKC, vet checked, shots, wormed, $200. 256-325-2430

Safety & occupational footwear safety shoes for professional use, size 9. 859-1188

2003 Epiphone Casino, sunburst, rarely played, w/ hardshell case, $570. 684-0910

Honda Harmony 215 mower, self-propelled, bag/mulch/ side, 5hp, blade control, $25. 881-8953

Bose 901 Series I speaker set, $80; wall gas heater w/tank, 26K BTU/hour, $60. 651-5847

Oak entertainment center/cabinet for big screen TV, $500. 256-415-2558

New Generation sleigh cherry finish crib w/o mattress and changing table, glider rocker, $130. 883-1779

Side-by-side Whirlpool gold refrigerator, black, ice/water in door, water filtration, $450. 461-9404

Minolta X-700 35mm camera w/lenses (28-70mm, 75-260mm, 50mm, 3x converter), flash, $480. 694-7399

Oak entertainment center, holds 27-36" TV, matching side pier, modern, paid $1,200, make offer. 829-0285

GE TV, 31", shelf for 150 lb. TV, Sony DVD player, blue sofa. 461-6337

Jet 3 Pride mobility power chair, $350; Sunbeam room ionizer w/timer, $50. 883-2125

Compound bow, Browning Ballistic Mirage, RH, weight 60-80 lbs., $150. 931-425-0205

Prom dress, fuchsia, junior size 13/14. 722-0237

HP Pavilion A340N desktop, 2.60GHz, 512MB, 120GV, DVD-ROM, w/17" monitor, speakers, $650. 652-0227

Ariens 32" riding lawn mower, 13HP. 651-8236

Boy's blue & orange jacket, XL (18-20), $30; Men's black leather bomber jacket, medium, $40. 683-9914

Pug, AKC, fawn, 1st shot, wormed, ready now, $350. 882-2037/David

Memory Stick, Pro-Duo, 1-gigabyte, high speed, use in Sony PSP, cell phone camera, etc., $66. 655-1986

The Beatles "Hard Day's Night" store display, approximately 5'x16"x12", $75. 303-3702/Decatur

Casio CTK-691 keyboard w/sustain pedal, stand, carrying bag, w/Musical Instrument Digital Interface, $200. 883-1003

Queen bed w/mattress set, contemporary brass, $500. 533-9683

Troy-Bilt tiller, Tuffy model, $275. 883-2653

IKEA solid birch loft bed w/double mattress, purchased Dec. 2005, $325. 658-1166

Italian white leather couch, love seat, and chair, $500; Gazelle, $75. 337-7943/leave message

Ariens rear-engine riding lawn mower w/bagger, $400. 721-0042

John Deere 660 tiller, $1,000. 256-772-9768

Vehicles

1995 Lexus ES300, 13.2K miles, sunroof, 6 CD changer, aluminum wheels, heated leather seats, $4,995. 457-6468

2001 VW Beetle, green, loaded, spoiler, automatic, heated leather seats, 85K miles, $9,200. 256-335-5896

1989 Tioga 27' Class C motor home & 2000 Saturn tow car, $25,000 for both. 536-7781

2002 Honda 600 Shadow, 7K miles, $3,000. 256-828-5142

2001 Toyota Tacoma Xtracab, pre-runner, red, 74K miles, warranty, V6/AT, SR5 trim, toolbox, $15,995. 683-9016

Honda Trail 70, second owner, runs, $550. 527-8116

1994 Coachman slide-in truck camper w/1995 Chevy 2500 truck, $8,250 for both. 379-3606

2005 Seadoo RXT PWC, 55 hrs. green/black, dealer maintained, under warranty, $9,900. 256-497-3518

2000 Pontiac Grand Prix GT coupe, all power, one owner, 126K miles, $6,500. 679-9203 after 5 p.m.

2002 Nissan Pathfinder, 6-CD Bose, automatic, power, step-rails, rack, 60K miles, greenish gray, $16,000. 880-9025

2003 Chevy Trailblazer LS, green, 49K miles, $15,500. 347-4804

1985 Ford Thunderbird, white, V8, runs, needs battery, $500 negotiable. 461-1269

2001 Dodge Durango, V8, 4WD, patriot blue, loaded, leather, auto, 66K miles, $15,000. 851-8775

1999 Honda Goldwing GL1500SE, white, AM/FM/CB/CP, extras, 4.5K miles, $10,300. 256-325-6347

2003 Mitsubishi Lancer, 45K miles, auto, CD, a/c, power windows, keyless entry, warranty, $9,000. 489-3120

2000 Blazer ZR2, 4x4, 2 door, black, loaded, cruise, keyless, hitch, roof rack, 119K miles. $5,600. 882-0404

Wanted

Players 55 & over for Huntsville Senior Slow Pitch Softball League. 859-7419/Ray or Fred/883-1135 for info

Boy's 12" bike or bike parts especially tires, seat, pedals, grips, training wheels. 651-4603

Queen bed set, box springs, mattress, frame, clean, affordable, less than $100. 313-655-7966

Free

Composted horse manure for your spring garden, will load for free. 420-8101

Mixed black Lab male puppy, 1 year old, vaccinated and neutered. 513-0966

Split firewood. 722-2821

Last day to purchase tickets for Marshall Retiree Luncheon is March 30

Marshall team members are invited to the Marshall Retirees Luncheon at the Redstone Officers' and Civilians' Club on April 6 at 11:30 a.m. The cost is $12. Contact Jill Stocks at 544-3711 or go to http://ohc.msfc.nasa.gov to buy tickets. Make checks payable to the Annual Retirees Banquet. The last day to purchase tickets is Thursday, March 30.

Great Moonbuggy Race to be held April 7-8

The 13th Great Moonbuggy Race will be Friday, April 7, and Saturday, April 8, at the U.S. Space & Rocket Center. For more information, visit http://moonbuggy.msfc.nasa.gov/ .

NASA strives to make flying safer and more comfortable

NASA Headquarters news release

Atmospheric turbulence encounters are the leading cause of injuries to passengers and flight crews in non-fatal airline accidents. Federal Aviation Administration statistics show an average of 58 airline passengers are hurt in U.S. turbulence incidents each year. Ninety-eight percent of those injuries happen because people don't have their seat belts fastened.

Atmospheric turbulence encounters are not only hazardous but they cost the airlines money and time in the form of re-routing flights, late arrivals, and additional inspections and maintenance to aircraft.

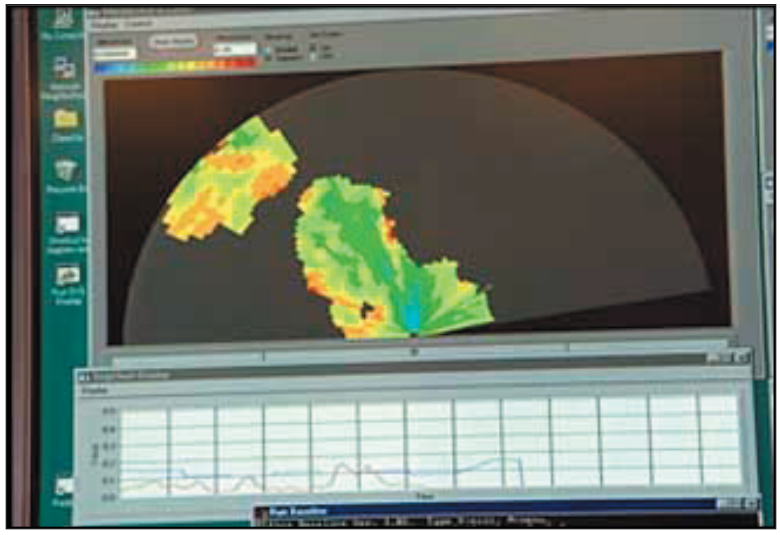


Photo credit: NASA Langley Research Center

The E-Turb radar system shows turbulence to pilots in a graphical display.

Engineers in NASA's Aviation Safety Program are working to tackle the issue of atmospheric turbulence with new technologies that will provide flight crews with enough advance warning so they can avoid turbulence or advise flight attendants and passengers to sit down and buckle up to avoid injury.

One promising technology called E-Turb, a modified radar unit that can detect turbulence associated with thunderstorms, has been flying on a Delta airliner since the summer of 2004. Delta flight crews have used and evaluated the technology during regularly scheduled flights in the United States and South America.

"The E-Turb radar technology is an enhanced radar system that detects atmospheric turbulence by measuring the motions of the moisture in the air," said Jim Watson, senior research engineer at NASA's Langley Research Center in Hampton, Va. "It is a software signal processing upgrade to existing predictive Doppler wind shear systems that are already on airplanes."

NASA teamed with Delta Air Lines, Atlanta; AeroTech Research, Hampton, Va.; and Rockwell Collins, Cedar Rapids, Iowa, for the in-service evaluation of the production-prototype airborne radar unit with turbulence hazard prediction capabilities.

Researchers from NASA, the Federal Aviation Administration, and the companies involved are currently evaluating the results of the turbulence prediction radar system tests. If E-Turb is found to help flight crews avoid turbulence, it may be adopted for use on new and existing aircraft.

Airliners from Delta are also testing another technology that could help alert pilots to turbulence called the Turbulence Auto Pilot Reporting System. Developed by researchers at NASA Langley and AeroTech Research Inc., this system displays automatic and timely reports of turbulence encounters immediately to computers on the ground and in the cockpits of other aircraft.

The system's processing of encounters takes into account how various aircraft respond to turbulence. Pilots can see the reports for the area ahead of their aircraft, controllers can see reports relative to air traffic, and airline personnel can evaluate the impact on their operations — all in real time.

NASA and industry researchers will continue to conduct in-flight evaluations of this system, which has been flying on 123 aircraft worldwide since August 2004.

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